

Arthur D Little

**Fuel Cell Development
Programs**

**Fuel Cell Auxiliary Power Systems
for Transportation Applications**

**October 30, 2001
Contractor Coordination
Meeting**

**USDOE OTT
Washington, D.C.**

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APU applications of fuels cells offer the potential for automotive-volume markets and possibly lower technical and cost barriers than propulsion.

- Fuel cells may be suitable as auxiliary power units for a range of vehicle types including trucks, recreational vehicles, SUVs, and high-end passenger vehicles
- Low emissions, low noise, and potentially high efficiency are key benefits fuel cells could offer
- Several technology and cost challenges must be overcome by both PEMFC and SOFC for widespread acceptance as APUs
 - Fuel may need to be widely available fuel, which would mean diesel or gasoline unless alternative propulsion fuels are popularized
 - Start-up times and power density must be significantly improved
 - Reliability must be proven and probably improved (APUs may run continuously, unlike propulsion engines)
 - Achieving a low manufacturing cost will be critical for broad SOFC and PEMFC commercialization but costs do not need to meet same \$/kW as for propulsion

Objectives

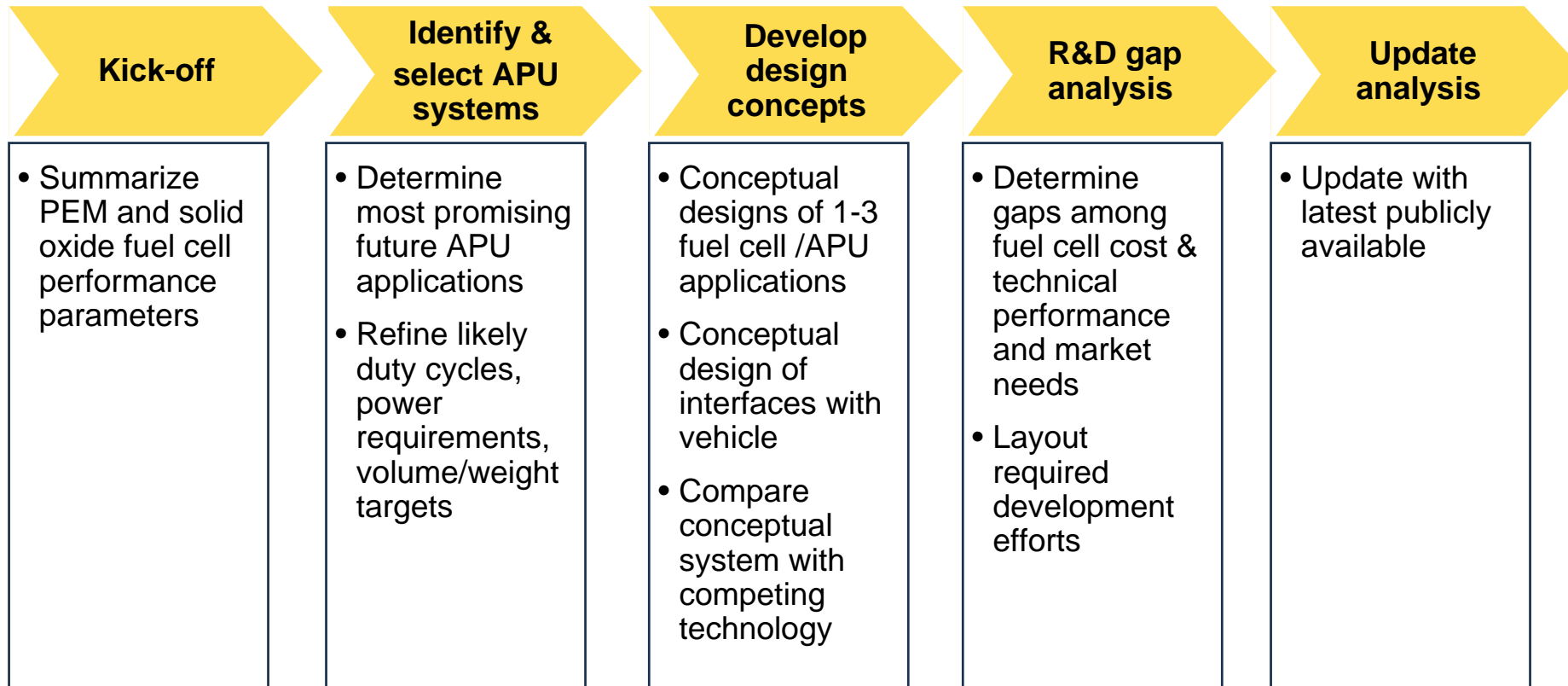
The objectives of this program are to assess the attractiveness of fuel cell APUs and to identify R&D efforts needed to enable their commercialization.

- Characterize potential APU applications
- Define vehicle interface requirements
- Develop conceptual fuel cell APU designs
- Compare designs with conventional alternatives
- Perform technology gap-analysis

Likely requirements that will require further systems development are fuel capability, water management, and operating life.

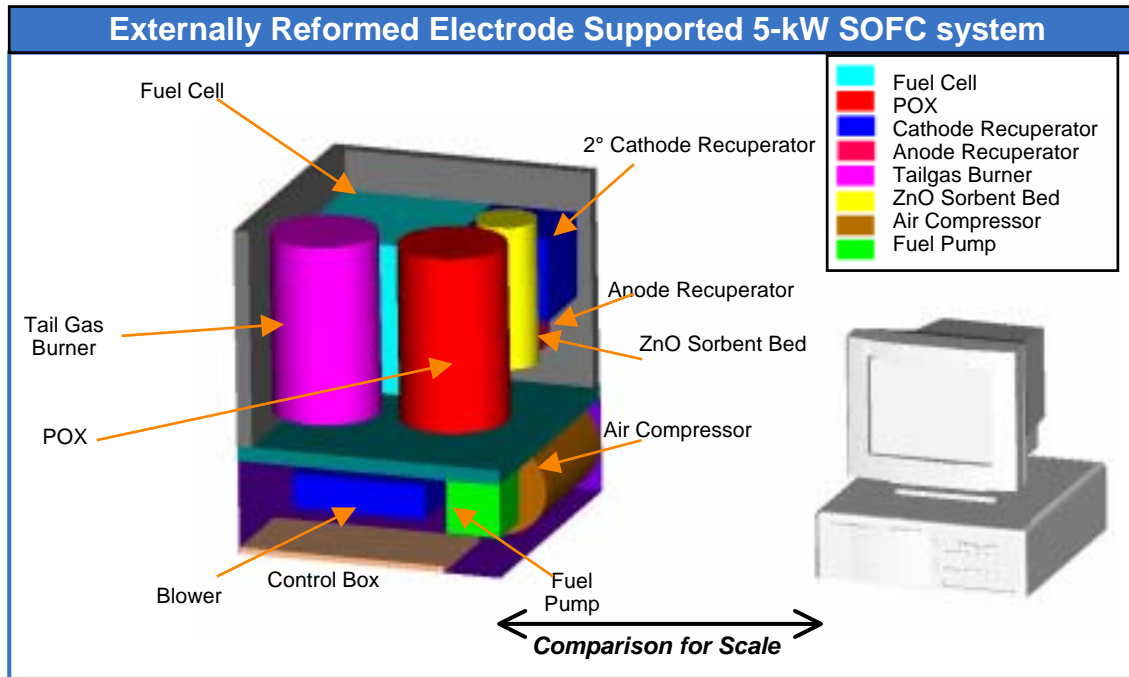
APU Requirements	
Voltage	12 - 42 (48) VDC and / or 110/220 VAC
Output	0.5 - 25 kW (probably with emphasis on 1-5 kW range)
Fuel Capability	Diesel fuel Gasoline LPG, Propane (RV, SUV)
Duty cycle	Continuous, load following, or cycling
Operating Life	Likely greater than 5000 hours, in some cases >40,000 hours
Power Density	Should be greater than 0.1 kW/kg and 0.1 kg//

We expect to develop detailed conceptual designs for up to 3 fuel cell/APU systems for on-road transportation applications.



We expect to analyze 1 SOFC application and 1-2 PEM-based systems.

We will develop similar conceptual designs as developed in our 5-kW SOFC study done for SECA/NETL.

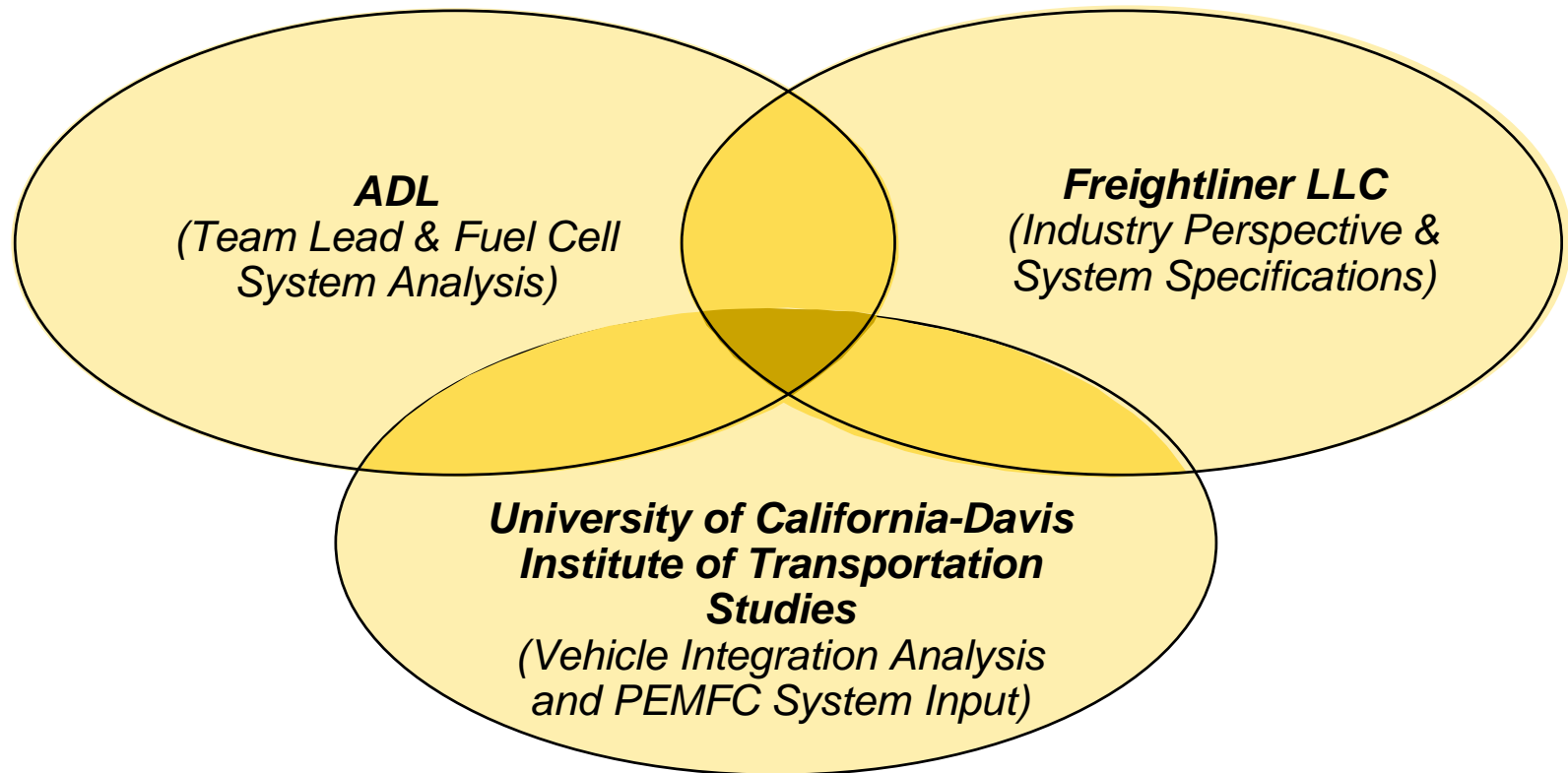


- Starting points are Arthur D. Little's:
 - Propulsion PEMFC analysis (for DOE OTT)
 - SOFC APU analysis (for NETL / SECA)
- Detailed process flow analysis & thermodynamic model
- Component conceptual design and specification
- Conceptual system integration
- Vehicle integration analysis (UC Davis)
- System cost analysis

We will use conceptual designs and layouts with manufacturing cost models.

Team Structure

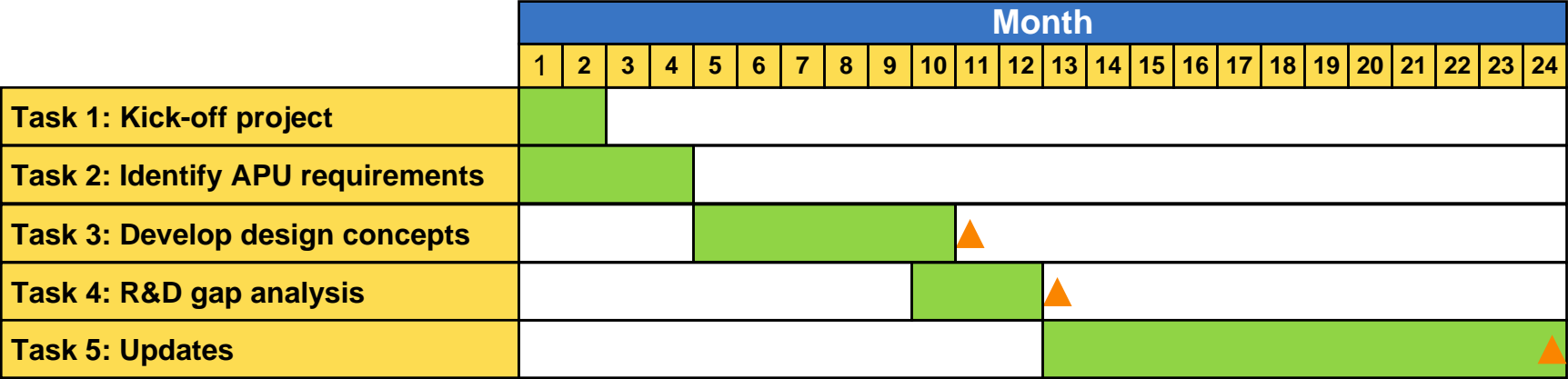
The DOE APU Fuel Cell Study Team consists of ADL and the University of California-Davis with input from Freightliner LLC.



This study will identify specifications, cost targets and markets for both PEM and SOFC based APUs for on-road transportation applications.

Schedule

Project schedule from award date:



▲ Meeting with DOE

We will solicit USDOE and industry input in the APU specification workshop (task 2, in Detroit around SAE Spring 2002 World Congress).

- The objectives of the workshop are:
 - Determine most promising future APU applications in terms of potential impact and select applications for detailed analysis
 - Agree on likely duty cycles, power requirements, fuel capability, volume/weight targets, efficiency, and first cost targets for the promising future APU applications
- We will ask feedback on the top three APU applications identified
 - For Cabin amenity application
 - Refrigeration application for heavy-duty truck
 - Third application to be agreed on (likely a SUV or high-end passenger car application)
- Feedback will be needed on proposed application requirements and associated APU specifications
- Participants will be briefed prior to meeting to allow preparation